

MARINE AQUACULTURE IN THE UNITED STATES: CURRENT AND FUTURE POLICY AND MANAGEMENT CHALLENGES

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Introduction

Aquaculture in the United States has the potential to become a major growth industry in the 21st Century. Global seafood demand is projected to increase by 70 percent by the year 2025 (Joint Subcommittee on Aquaculture, JSA 1993). With harvests from capture fisheries stable or in decline, aquaculture would have to increase production by 700 percent to a total of 77 million metric tonnes annually to meet the projected demand (JSA 1993). The potential of aquaculture worldwide to meet the challenges of food security and to generate employment has been demonstrated by its rapid growth at an annual rate of 10 percent since 1984 (as compared with 3 percent for livestock meat and 1.6 percent for capture fisheries production) (FAO 1997).

The United States currently imports more than 60 percent of its fish and shellfish. In 1996, \$6.8 billion of seafood products were imported, while \$3.0 billion were exported. In 1997 seafood imports increased to \$7.8 billion, while exports decreased to \$2.7 billion, representing a \$5.1 billion trade deficit (NOAA—NMFS, 1998). Seafood products are the nation's largest agricultural import, second only to petroleum (JSA 1993). Each year, Americans consume more than \$800 million of foreign-grown aquaculture products. Obviously, domestic aquaculture production has not grown at a rate necessary to offset the consumer demand for seafood.

Nevertheless, the development of the U.S. aquaculture industry is felt to be vital to the future of the

nation because it promises to produce: (1) high quality seafood to replace that supplied through the harvests of wild stock in decline or at maximum sustainable yields; (2) products for export to help reduce the nation's foreign trade deficit; (3) stock enhancement of important commercial and recreational fisheries species; (4) economic development opportunities for rural and suburban communities; and (5) new employment opportunities for skilled workers (National Research Council, NRC 1992).

Marine Aquaculture in the United States

The U.S. marine aquaculture industry is extremely young. While the culture of freshwater species such as catfish and trout has existed for many decades, the cultivation of marine species has emerged only over the last 30 years. Total production from all domestic aquaculture operations grew from 572.5 million pounds in 1990 to 693.7 million pounds in 1996, a 21 percent increase, while marine aquaculture production alone went from 49.3 to 66.8 million pounds, a 35.5 percent increase over the same time. In 1996, about 86 percent of U.S. marine aquaculture yield was represented by oyster and salmon production, with oyster production declining and salmon production greatly increasing from 1990 to 1996. More than 50 species made up the remaining 12 percent. While the U.S. marine aquaculture industry is relatively small, it remains vital since most of the huge seafood deficit in fishery products comes from the import of marine, not freshwater, seafood (Sandifer 1994).

Aquaculture is now practiced in more than 80 percent of the states and territories of the United States. Nevertheless, cultivation of all marine species,

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except oysters, is in the early stages of commercial development in the United States, and many operations have yet to achieve economic stability (NRC 1992). It goes without saying that the U.S. marine aquaculture industry has not kept pace with the growth of the world industry during the last 25 years (NRC 1992).

The future for marine aquaculture in the United States is much less certain than that of its freshwater counterpart. One serious problem is that most marine aquaculture is conducted in shallow coastal and estuarine waters, which are affected by increasing population pressures and industrial and residential development. By the year 2010, 70 percent of the total population of the United States will live within 120 kilometers of the coast (Culliton et al. 1990). In addition, whereas the transition from fishing to aquaculture in freshwater systems is analogous to that of hunting to farming, marine aquaculturists face an additional hurdle — they have no property interest in the “lands” they need (Nixon 1994). Because the ocean has traditionally been viewed as a common property resource, there are also conflicts with other commercial and recreational users which may slow or prevent the development of marine aquaculture (Harvey 1994).

Growth of the domestic marine aquaculture industry is dependent upon the attainment of 4 basic requirements (DeVoe and Mount 1989): high water-quality locations; access to the aquaculture site; assertion of exclusive fishing and culturing rights; and financial investment. These authors also argue that government commitment, in the case of marine aquaculture, may be the most critical. Government must demonstrate its support by clearly defining the term aquaculture, providing supporting policy statements and implementation strategies, offering incentives (which do not necessarily have to be solely financial) to underscore its commitment, and defining and streamlining its regulatory and legal requirements.

Issues Confronting Marine Aquaculture

There are a number of issues that have constrained the development of marine aquaculture in the United States. The complex and diverse nature of the

industry, conflicts with other, traditional, uses of the nation’s coastal and ocean waters, environmental concerns, and the existing legal and regulatory climate all contribute to this situation.

Nature of the Marine Aquaculture Industry

Marine aquaculture represents a relatively new use of the nation’s coastal resources, and it must compete for access to those resources (Nixon 1994). Newcomers to the industry, as well as local authorities, suffer from a lack of experience, inappropriate advice on site selection, inadequate evaluation of market opportunities and product diversification, and a lack of understanding of marine aquaculture development in relation to other forms of competition (Chamberlain and Rosenthal 1995). Much of this confusion stems from its uniqueness and complexity.

A number of finfish, shellfish, and crustacean species are cultivated in the United States, including catfish,

trout, salmon, striped and hybrid bass, tilapia, hard clams, oysters, mussels, crawfish, and penaeid shrimps. The industry is technologically diverse, with ponds, raceways, silo, circular pools, closed (water reuse) systems, cages and net-pens, sea ranches, rafts, and long lines used according to the species cultured (JSA 1983). Aquaculture remains a relatively young scientific discipline that is developing rapidly, with

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incorporation of a variety of modern technologies, most not yet fully adapted for widespread use (Rosenthal 1985). Indeed, there has been a trend toward intensification in both traditional and contemporary culture systems.

Aquaculture practices range from extensive, with few inputs and modest output, to intensive, with high inputs and output. On an annual yield per hectare of water basis, increased intensification requires greater

resource use, ranging from simple pond culture to intensive tank and closed system aquaculture (Muir 1985). These varying technologies are what make aquaculture the diverse industry it is, but they have wide—ranging resource needs, produce differing environmental impacts, and require a suite of technological and management responses.

Further complicating the future of marine aquaculture is the complexity that stems from unique factors that distinguish it from other forms of agricultural activity, including: (1) the interaction of marine aquaculture with other marine and coastal activities and interests—interactions that are often characterized by conflict; (2) the fact that although marine aquaculture is ocean-based, it depends on the use of land and freshwater resources as well; and (3) the numerous environmental and regulatory considerations involved in the development and use of coastal zone land and water resources, usually held in the public trust (NRC 1992).

Coastal and Ocean Use Conflicts

While culturists, scientists, and resource managers face the task of resolving these issues through research studies, monitoring programs, and technical assistance support, the marine aquaculture industry continues to deal with its “growing pains.” In a recent survey of state aquaculture coordinators, industry representatives, and extension specialists, Sandifer (1994) found that only 9 out of the country’s 24 coastal states and 5 territories reported moderate growth, and 8 no growth. Asked to identify the major factors responsible for this situation, the respondents indicated that of 12 limiting factors, the top three were use conflicts (92%), permitting (92%) and the regulatory environment (88%) (Sandifer 1994).

Use conflicts represent one of the primary issues U.S. marine aquaculturists must face, and are likely to become more pronounced and frequent in the future (Chamberlain and Rosenthal 1995). DeVoe et al. (1992) found through a survey of the marine aquaculture industry and state regulatory agencies that the competing use of the coastal zone by recreational users, commercial fishermen, and developers was frequently encountered. The escalating costs of acquiring access to coastal lands and waters in the country exacerbate the problem.

In 1992, the National Research Council of the National Academy of Sciences predicted that, due to increasing pressures along the coastal zone, the best

opportunities for future commercial aquaculture development are in recirculating (closed) systems on land and in confinement systems in the open ocean. Research and development emphasis has been on closed system aquaculture rather than on offshore facilities. Yet, after more than 20 years of R&D activity, the economic viability of closed system aquaculture remains elusive. The United States is only now exploring the potential for establishing facilities in unprotected offshore areas.

Aquaculture and the Environment

Much has been published over the last 15 years on the environmental impacts of marine aquaculture (e.g., Ackefors and Sodergren 1985, Weston 1986, Rosenthal et al 1988, DeVoe 1992, Goldberg and Triplett 1997, Naylor et al. 1998, also see *Estuaries*, Vol 18: 1A, 1995). However, ecological concerns had been raised by a number of authors in the 1970s (Odum 1974, Ackefors and Rosen 1979). One of the major challenges to the marine aquaculture industry in the United States will be how it responds to these environmental sustainability issues (Chamberlain and Rosenthal 1995).

Aquaculture practices can generate environmental impacts as a function of (1) the applied technique, (2) site location, (3) size of the production, and (4) capacity of the receiving body of water (Ackefors and Sodergren 1985). These can include impacts on water quality, the benthic layer, the native gene pool, and the ecosystem as a whole, and impacts from non-native species, disease, and chemicals.

The state of knowledge regarding the environmental impacts of aquaculture is rapidly improving. Whereas two decades ago very little research data were available, there has been a surge in the number and scope of research and monitoring programs seeking to document these effects. Much work worldwide has focused on the effects of net-pen culture on the environment, with the International Council for the Exploration of the Sea (ICES) leading the way. In the United States, early research efforts dealt with fish hatchery effluents and catfish ponds. As the domestic industry diversified, so did environmental research, with major federal studies examining the impacts of marine shrimp pond culture and salmon net—pen culture, and the issues regarding species introductions, the use of chemicals in aquaculture, and effluent discharges.

Legal and Regulatory Structures

The current regulatory environment for marine aquaculture in the United States is a major constraint to its development (NRC 1978, NRC 1992, JSA 1993, and others). No formal federal framework exists to govern the leasing and development of private commercial aquaculture activities in public waters (NRC 1992).

In a 1981 study commissioned by the Joint Subcommittee on Aquaculture, the Aspen Corporation examined the federal and state regulatory framework for aquaculture (Aspen Corp. 1981). As many as 11 federal agencies are directly involved in regulating aquaculture and another 10 are indirectly involved. However, only a limited number of permitting and licensing requirements are directly imposed by federal agencies. More characteristic are federal agency programs that indirectly regulate fish farmers (e.g., restrictions on drug use, federal laws administered by states, etc.).

Some 50 federal statutes (with accompanying regulations) were found to have a direct impact on the aquaculture industry, although the actual number of statutes that affect an individual operation vary depending on its size, location, the species being cultured, and other factors. In total, over 120 statutory programs of the federal government were found to significantly affect aquaculture development. About one-half require direct compliance from the fish farmer.

Seven federal agencies have regulatory programs that directly affect the marine aquaculture industry: the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the U.S. Food and Drug Administration, the U.S. Department of Agriculture, the U.S. National Marine Fisheries Service, and the U.S. Coast Guard. Federal oversight of the marine aquaculture industry is fragmented; there is no overall federal framework to address aquaculture development in the coastal zone or offshore waters. Further, while recent evaluations of marine aquaculture suggest that offshore locations may represent a viable alternative (NRC 1992), no formal policies have been developed to manage aquaculture development in the U.S. Exclusive Economic Zone. As a result, existing federal policies vary from one agency to another (and may even differ among divisions within the same agency) and the permitting process can be time-consuming, complex, and costly.

The majority of laws and regulations that specifically authorize, permit, or control aquaculture are usually found at the state level. The Aspen Corp. study examined 32 state regulatory programs and discovered that over 1,200 state laws have some significant bearing on aquaculture operations. Policies and regulations were found to affect aquaculture in eight major areas: aquaculture species use; water quality; water use; land use; facility and hatchery management; processing; financial assistance; and occupational safety and health.

Major aquaculture problems that arise from state laws and regulations are caused by the lack of uniformity of laws among the states, the sheer number of permits, licenses, and certifications that must be obtained, and the difficulty in obtaining them (NRC 1978, 1992). Each state has its own unique legal, political, and economic climate for aquaculture, and culturists must navigate the regulatory environment differently in each. Only a few states have developed the information management capability to present the applicant with a comprehensive list of all the legal requirements that must be met. State regulatory programs can be and usually are more restrictive than federal guidelines and regulations dictate. The result is that state agencies vary greatly as to what standards they apply to aquaculture (McCoy 1989), and some still apply laws designed for other applications such as those for public fisheries management (NRC 1978, 1992).

Federal agencies which establish the ground rules that most state agencies must follow have adopted vague, confusing, and poorly conceived regulations, or none at all (McCoy 1989). This translates into inconsistencies in the development and application of laws and regulations at the state level (deFur and Radar 1995). Few states have a comprehensive regulatory plan which satisfactorily balances economic development and environmental protection. As a result, regulations governing aquaculture are scattered throughout state statutes and do not necessarily fit aquaculture (Breux 1992). Complicating matters is the fact that existing permit programs do not have provisions for determining the capacity of the coastal and estuarine system for aquaculture, land-based or in situ (deFur and Radar 1995).

The complexity that results from the involvement of many federal, state, and local agencies responsible for all aspects (including advocacy, promotion, conduct, and regulation) of marine aquaculture leads to an array of planning acts, policies, and regulations

(NRC 1992). Federal laws are applied differently in various geographic regions of the country (NRC 1978), and the industry remains concerned about the lack of coordination among agencies regulating aquaculture (JSA 1993). Unfortunately, the federal government has yet to make any significant headway in reducing regulatory constraints (McCoy 1989).

Another limitation to the current regulatory regime for marine aquaculture in the United States is the lack of long-range and whole systems planning (deFur and Radar 1995). Aquaculture policy appears to be made by granting permits on a case-by-case basis (Rubino and Wilson 1993), and the requirements are often determined using regulations and technical standards not originally developed or intended for aquaculture (Ewart et al, 1995). Each permit is considered individually by the issuing agency, usually with no provision for examining cumulative impacts (deFur and Radar 1995).

Marine Aquaculture and Federal Policy

On September 26, 1980, the National Aquaculture Act of 1980 was passed to “promote aquaculture in the United States” through a declaration of a national policy, development and implementation of a national aquaculture development plan, establishment of a coordinating group of federal agency representatives, establishment of a National Aquaculture Information Center, and encouragement of aquaculture activities and programs in both the public and private sectors. The 1980 Act was amended in 1985 and 1990, and reauthorized most recently in 1998.

The Act clearly states an aquaculture policy for the country: that it is “in the national interest, and it is the national policy, to encourage the development of aquaculture in the United States.” The National Aquaculture Act of 1980 gives principal responsibility for the development of aquaculture to the private sector but jointly assigned three federal agencies aquacultural-related responsibilities- the Departments of Agriculture, Commerce, and Interior. An Interagency Agreement was reached among these agencies regarding “Designation of Areas of Responsibility in Aquaculture.”

The Joint Subcommittee on Aquaculture (JSA) was created to serve as a federal interagency coordinating group to increase the overall effectiveness and productivity of federal aquaculture research, technology transfer, and assistance programs. While receiving no direct funding, the JSA, composed of the heads or their designees of more than 12 federal

agencies, is generally thought of as a model coordinating mechanism. The JSA exists now as a statutory committee that operates under the aegis of the National Science and Technology Council (NSTC) of the Office of Science and Technology Policy in the Office of the Science Advisor to the President. The JSA reports to the NSTC’s Committee on Health, Safety and Food Research and Development, which is one of nine research and development committees established by NSTC to prepare coordinated R&D strategies and budget recommendations for accomplishing national goals. Chairmanship of the JSA was originally planned to rotate among the Secretaries of the three primary departments; however, the 1985 amendments specifically established the Secretary of Agriculture as permanent chair of the JSA.

The JSA completed the first and only version of a national aquaculture development plan in 1983. Volume I of the plan presented information on the status of aquaculture, current technologies, impediments to development, existing federal programs, recommended programs and actions, and anticipated impacts. Volume II reviewed those aquatic species that have or show potential for development as aquaculture products. Unfortunately, no assessment regarding progress on the original plan’s recommendations was ever made. It was not until 1996 that revision of the 1983 plan was considered. A draft updated national aquaculture development plan is now being finalized for submission to the NSTC for review and comment.

The National Aquaculture Act of 1980 and its amendments provide a federal policy framework for and endorsement of aquaculture in the United States. The 1983 plan constituted the first coordinated effort in the United States to assess the aquaculture industry, identify its needs, and suggest steps to improve the climate for aquaculture development. The JSA also provides a mechanism whereby information exchange and program coordination can occur. Nevertheless, although the 1980 Act was reauthorized in 1998 as part of the Farm Bill, recent failure of legislation explicitly extending and funding the 1980 Act suggests that difficulties persist in seeking a consensus on a government policy for aquaculture.

The Future of Marine Aquaculture in the United States

The reasons that marine aquaculture has not progressed as rapidly as freshwater aquaculture are as complex as the nature of the industry itself. These issues manifest themselves not only at the federal

level, but in each of the nation's coastal states as well. Progress is occurring throughout the country, albeit at a fairly slow pace. The potential of marine aquaculture remains high as research information and technologies continue to be generated for cultivating a diversity of marine species, ameliorating the real environmental effects of the industry, and developing cost—effective and sustainable culture techniques and practices. Realization of that potential is being severely limited by many institutional and legal constraints and sustainability issues.

These issues are not new to the industry or to government. Conclusions of two National Research Council (National Academy of Sciences) panels that met in 1978 and 1992 to review the growth and potential of the U.S. aquaculture industry are enlightening. In 1978, an NRC panel concluded that constraints on the development of the U.S. aquaculture industry “tend to be political and administrative, rather than scientific and technological” (NRC 1978). Fourteen years later, a second NRC panel stated that “solutions to the environmental problems constraining marine aquaculture will involve approaches that combine technological ‘fixes’ with improved regulatory and management structures, as well as public education” (NRC 1992). It is unfortunate that many of the issues identified in 1978 and again in 1992 remain unresolved to this day.

Becker and Buck (1997) identify an important factor that has not seriously been considered by aquaculture pundits; that is, the federal government has actually put itself in a conflict-of-interest position vis-à-vis its roles in aquaculture. On one hand, it acts as enforcer of regulatory requirements aimed at protecting consumers, natural resources, and the environment and, on the other, as administrator of programs that support and promote the growth of the industry. What results is a tug-of-war where progress is difficult to achieve. Obvious in their analysis is the view that complete consensus on the future role of the federal government in support of aquaculture will be difficult to achieve.

In addition to the many federal departments and agencies that are involved in aquaculture policy, regulation, management, and/or support, Becker and Buck (1997) point out that jurisdiction over aquaculture-related issues is divided among several congressional committees as well. In the Senate, aquaculture and related issues are divided among the Committees on Agriculture, Nutrition and Forestry; Commerce, Science and Transportation; Energy and Natural Resources; Environment and

Public Works; and Labor and Human Resources. On the House side, the Agriculture Committee, Commerce Committee, and Resources Committee have jurisdiction over components of aquaculture. Of course, each of these committees has different mandates and responsibilities which may overlap at times, and each has its own agenda and perspective on aquaculture issues and needs. These committees must also deal with a wide range of constituencies, some of which may take positions counter to those of the marine aquaculture industry. Here again, reaching agreement on issues related to aquaculture can be difficult.

Whither U.S. Marine Aquaculture Policy?

There have been many studies and analyses conducted over the last 20 years by federal agency, congressional office, academic, and industry authors examining the issues facing the U.S. marine aquaculture sector and offering a myriad of recommendations and strategies to address them (e.g., NRC 1978, DeVoe and Mount 1989, NRC 1992, Rubino and Wilson 1993, Stickney 1994, DeVoe 1994, DeVoe 1997). While these authors and others have provided reasonable and proactive suggestions for enhancing the marine aquaculture industry, the situation in general has changed little over that time. Why?

The United States must return to the more fundamental issues to address the lack of growth of the marine aquaculture industry. More to the point, the country must:

1. Reevaluate and Reaffirm the Nation's Aquaculture Policy

While Japan continues to focus use of its coastal and marine resources on food production, the United States continues to look to the coast and ocean for recreation, tourism, and other economic pursuits. We as a country of plenty have not had to look to the seas to provide sustenance for our citizens. Pressures to effect a major cultural change in the way we now use our coastal and marine resources have not risen to a critical level; why change when we can import seafood from overseas? The impetus to unite the industry, U.S. Congress, the federal agencies, the states, and constituents together to create this cultural shift has been lacking. As a result, marine aquaculture's place among the many uses of the nation's coastal and ocean waters is not as yet established.

The National Aquaculture Act of 1980 contains a clear and unambiguous statement in support of aquaculture development in the United States. The United States, through Congress and the Administration, with the support of industry and the involvement of all constituencies, must take a hard look at the current situation and decide if it wishes to aggressively pursue the policy. Many scholars, academics, industry leaders, and others have offered a wide range of possible solutions to address the constraints limiting marine aquaculture development, but without strong commitment and leadership by the federal government to work toward this goal, the current situation will be hard to improve.

2. Support Sustainable Marine Aquaculture

Marine aquaculture in coastal and offshore waters of the United States must be developed with an eye toward sustainability — with a goal of producing products while conserving natural resources. Its development must have a solid ecological perspective that is compatible with the social, economic, and environmental goals of coastal communities, which will require the active involvement of community leaders and other relevant parties in the process. The development and use of risk assessment tools, best management practices, and educational and training programs must be incorporated into all federal efforts to develop and support the industry. The development of environmental criteria for marine aquaculture operations must be based on the generation of science-based information. These and other factors must be incorporated into federal policies and plans if we are to see the marine aquaculture sector grow in the future.

3. Strengthen Policy Development through Improved Coordination

Assuming the United States is truly committed to the development of the marine aquaculture industry, mechanisms must be put into place to refine existing and establish new implementation measures to guide its growth. The fundamental framework to meet this challenge already exists with the Joint Subcommittee on Aquaculture. Currently, JSA plays an important role in coordinating federal agency activities and ensuring communication among the agencies in the areas of research, transfer, and assistance programs in aquaculture, and providing recommendations for federal aquaculture policy. The potential for enhancing the role of the JSA in dealing with and resolving the many issues facing marine aquaculture lies with its membership. However, it presently operates

without a budget, participation by any of the agencies is not mandatory, and there is no formal voting structure nor dispute resolution process in place. Areas where the role of the JSA could be strengthened include:

a. Status of the JSA

- * The role of the JSA in the administration should be expanded to include policy development and implementation.

- * The permanence of the JSA should be established through the provision of a stable source of funding and staff assistance to improve coordination and consistency of policy development and implementation.

- * The JSA should enhance the involvement of key representatives from the marine aquaculture industry, environmental community, and other constituencies in its deliberations and decision-making.

b. Federal Permitting and Regulatory Structure

- * The JSA should be charged with designing a streamlined planning and permitting framework for marine aquaculture activities in the coastal zone, emphasizing joint local, state, and federal coordination in consultation with the marine aquaculture industry, the states, and pertinent constituencies.

- * The JSA should be charged with the primary responsibility for developing a coordinated management and regulatory framework for offshore aquaculture activities, in consultation with all relevant federal and state agencies and constituencies.

c. Federal Research and Development Activities

- * The JSA should conduct an assessment of all ongoing federal funding programs to assess the nature and scope of current activities and whether they are meeting the needs of the industry and the public.

- * The JSA should, based on the assessment, develop a coordinated, cross-cutting funding plan to ensure that future key needs and issues related to marine aquaculture are being addressed in an efficient and non-duplicative manner.

Conclusion

The key to the future of marine aquaculture in the United States is the creation of technological and political systems that provide for sustainable marine aquaculture. Sustainable aquaculture will only be achieved if all facets of the industry — production and technology, economics and marketing, business and financing, natural resource needs and protections, and administrative and legal institutions — are dealt with simultaneously. This is a lofty goal, given the diverse nature of the marine aquaculture industry, but the modus operandi of the last three decades in dealing with the needs of the industry will not be enough. Systems that will move the industry forward will require an unequivocal commitment by the nation's political leadership to create them, by the federal bureaucracy to implement them, by the academic community to generate and extend information to improve them, and by the industry to put them into practice. Coordination, cooperation, communication, and education will be the primary tools required to move the United States toward a viable and sustainable marine aquaculture industry.

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